



CMS and LHC Update



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For the CMS Collaboration

December 7, 2009

All Experimenters' Meeting



Timeline: Circulation



- Nov 7-9: Beam shots onto collimators near CMS (“splashes”)
 - CMS took data with calorimeters on, muon chambers at standby, and silicon tracker (strips and pixels) off. Solenoid also off.
- Nov 20: Both beams circulated (individually) at injection $E = 450$ GeV
 - CMS took data, same as above

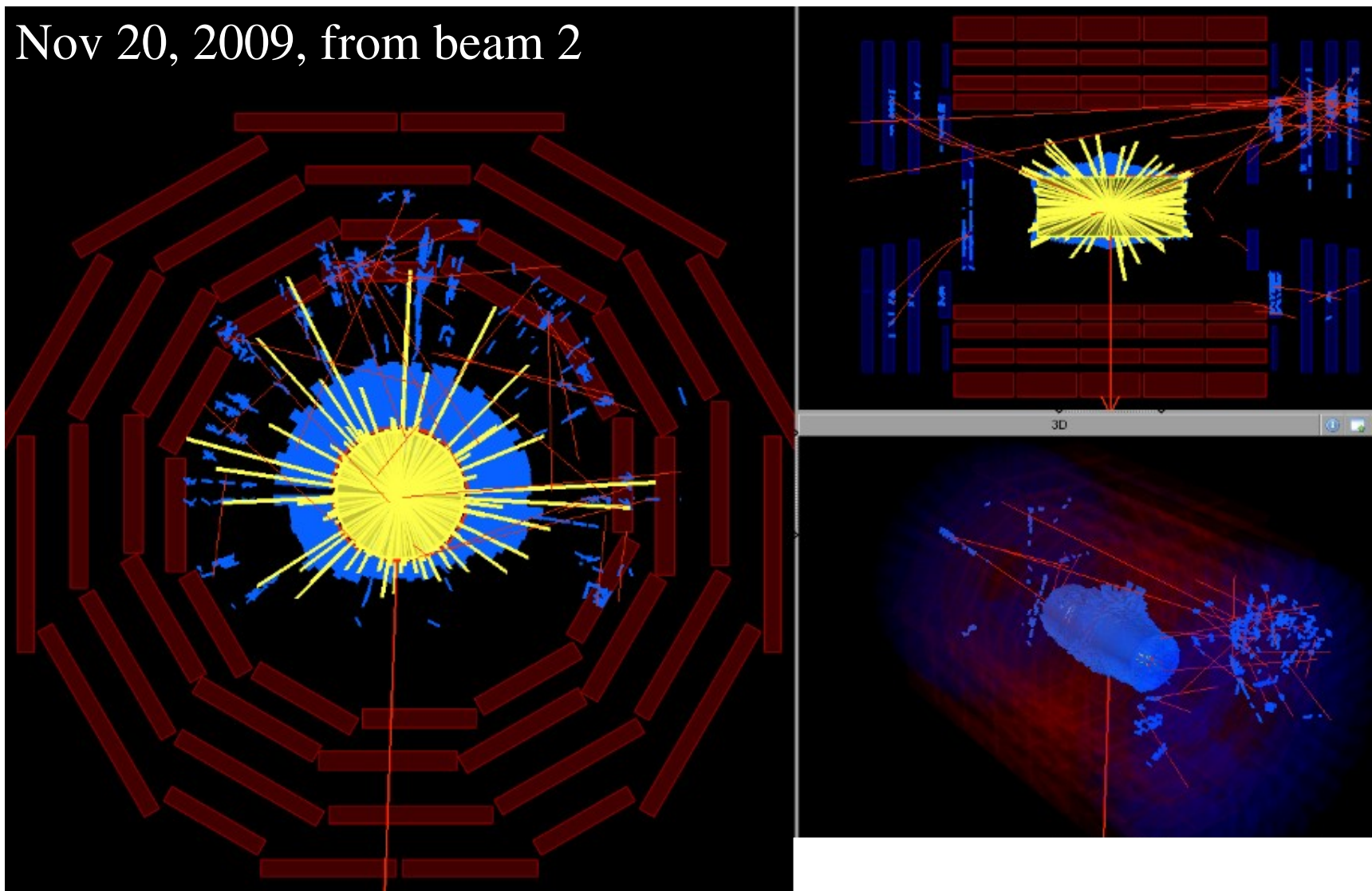


Splash Event



- Beam-on-collimator “splash” event

Nov 20, 2009, from beam 2





Scraping Event



- Less **ECAL** and **HCAL** energy than in beam-onto-collimator events

CMS Experiment, CERN Nov 20, 2009, during beam 1 circulation

Data_taken 2009-Nov-20 19:43:21.080722 GMT

Run_no 121949
Event_no 90
Lumi_sec 18
Orbit 18809527
Crossing 342
<http://iguana.cern.ch/ispy>

Beam 1

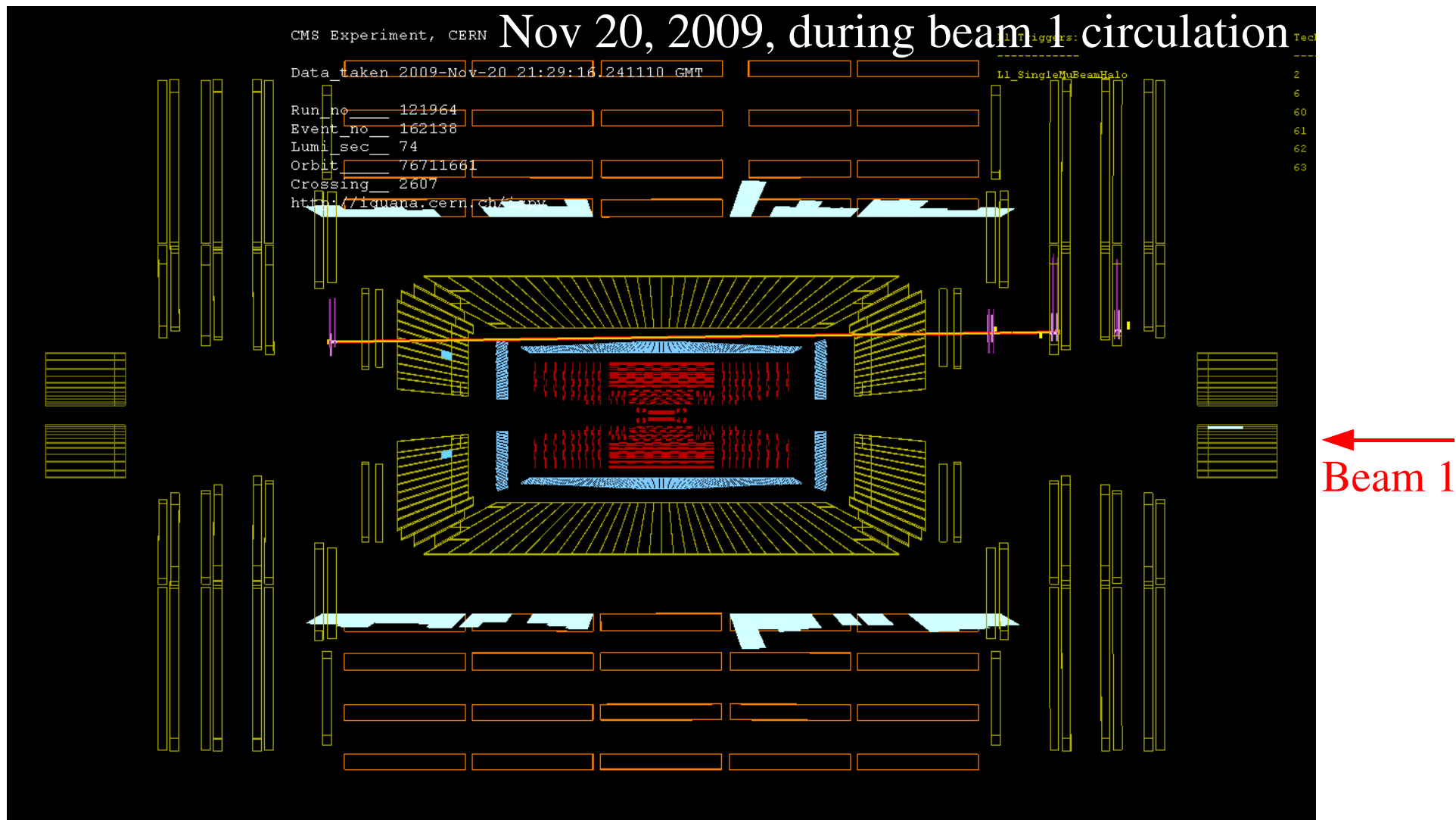
ECAL activity
near beam line



Beam Halo Muon



- Halo muon leaves hits in **Resistive Plate Chambers** & **Cathode Strip Chambers**

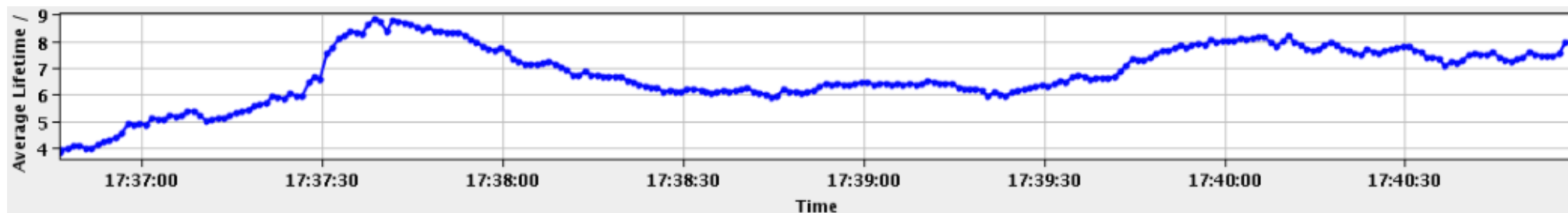




Timeline: LifETIME



- Nov 21: Achieved ~6 hour average beam lifetime



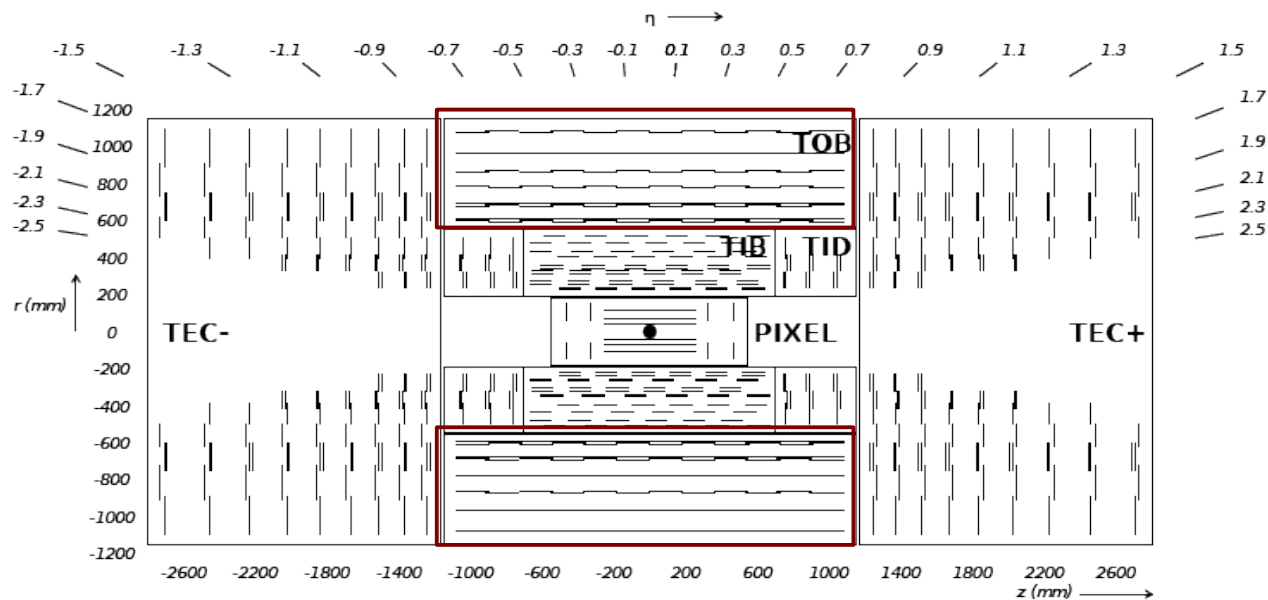
- CMS took data as before, but with endcap muon chambers at operating voltage to accumulate beam halo events



Timeline: Collisions



- Nov 23: First collisions! Beam lifetimes ~ 10 hours.
 - CMS took data in special configuration:
 - Calorimeters and muon systems on
 - Tracker Outer Barrel (TOB) on:



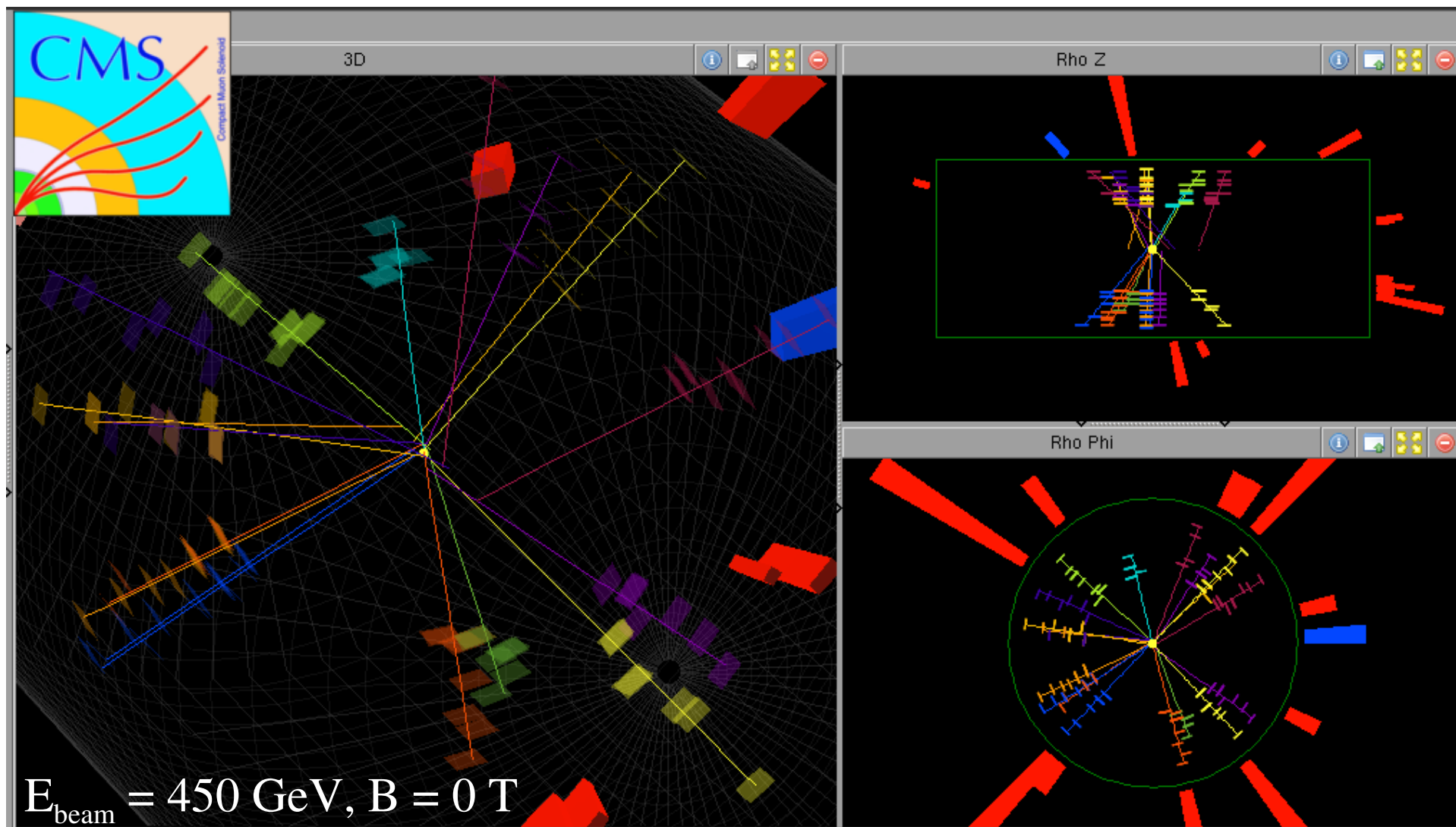
- Rest of tracker silicon strips and pixels off
- Solenoid magnet still off



Collision Event



- Nov. 23, 2009 19:26 UTC. Run 122314, Event 8605569

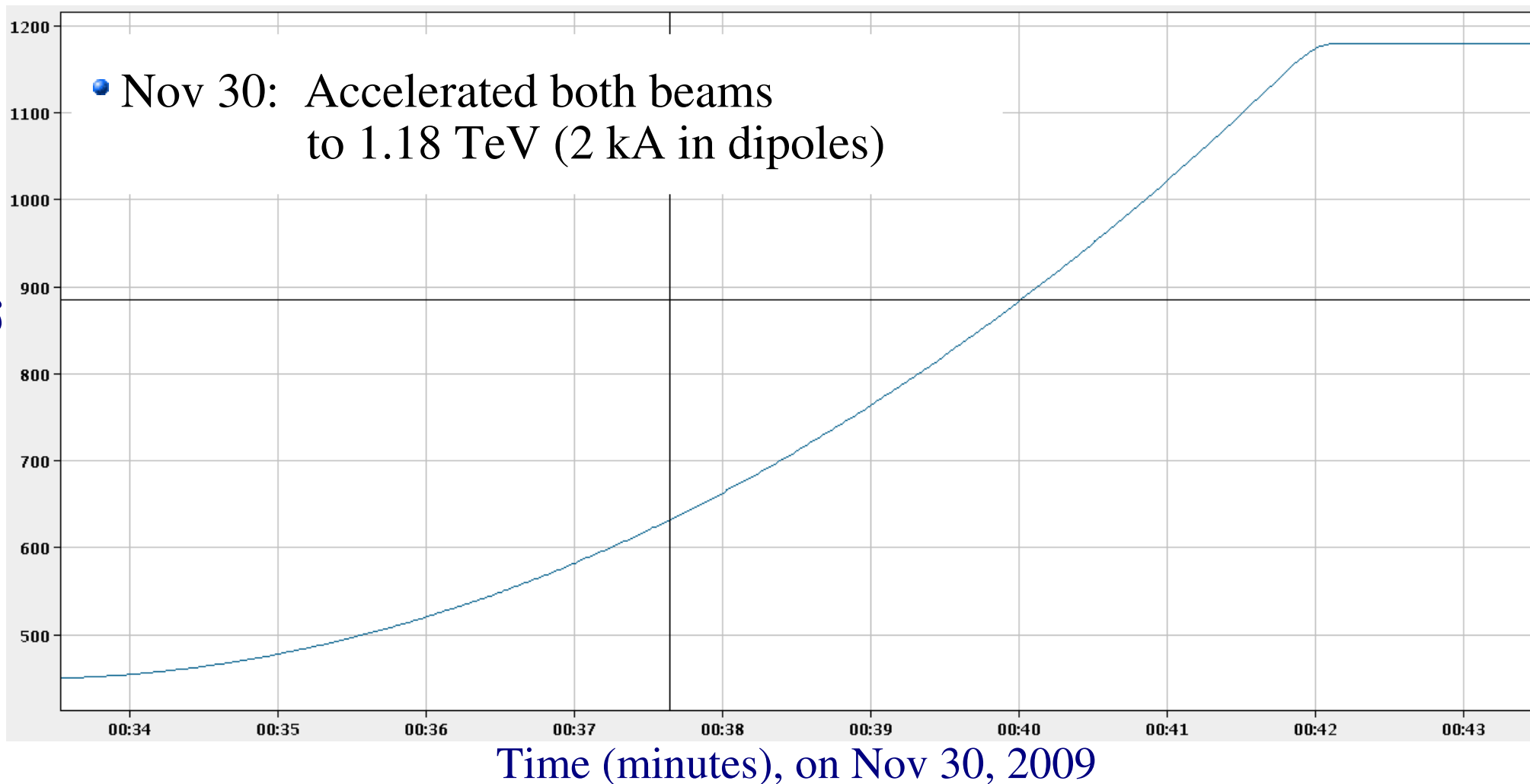




Timeline: Ramp



- Nov 24: Accelerated beam to 560 GeV
- Nov 29: Accelerated beam 1 from 450 GeV to world record 1.05 TeV





Timeline: Stable Beams

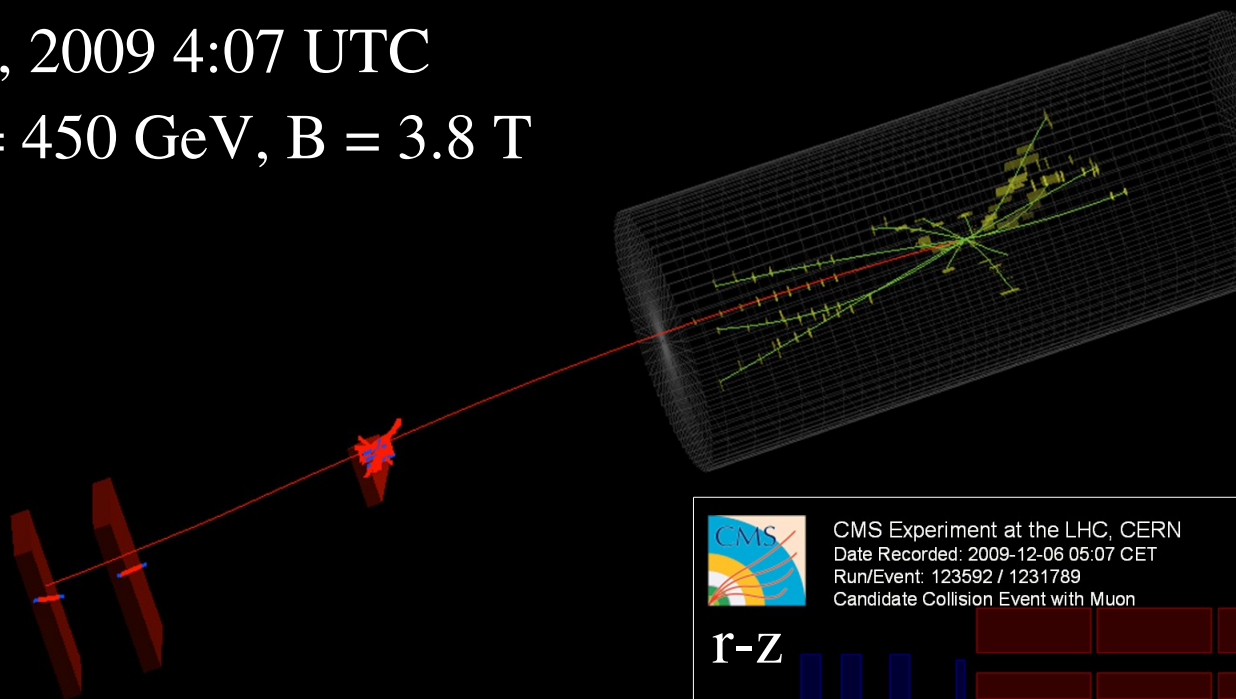


- Nov 30: CMS solenoid ramped to 3.8 T, with both beams circulating
- Dec 4: Injection of first multi-bunch beam
 - Two bunches with $\sim 4\text{E}9$ protons / bunch in beam 2
- Dec 6: 4 bunch x 4 bunch collisions ($\sim 5\text{E}9$ protons / bunch)
 - 3 *Fills* (what FNAL calls *stores*), with one that lasted 4 hours
 - CMS took data with
 - All detectors ON, including silicon tracker and pixels
 - Magnetic field ON
 - Collision rate of approximately 2 Hz

Candidate Muon Event

Dec. 6, 2009 4:07 UTC

$E_{\text{beam}} = 450 \text{ GeV}$, $B = 3.8 \text{ T}$



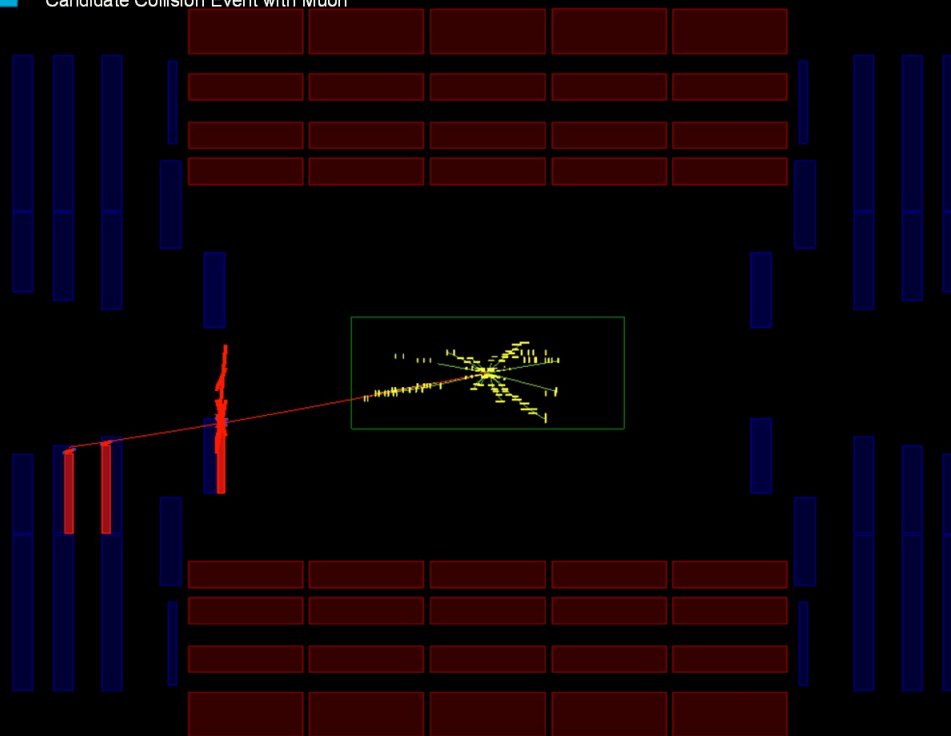
CMS Experiment at the LHC, CERN

Date Recorded: 2009-12-06 05:07 CET

Run/Event: 123592 / 1231789

Candidate Collision Event with Muon

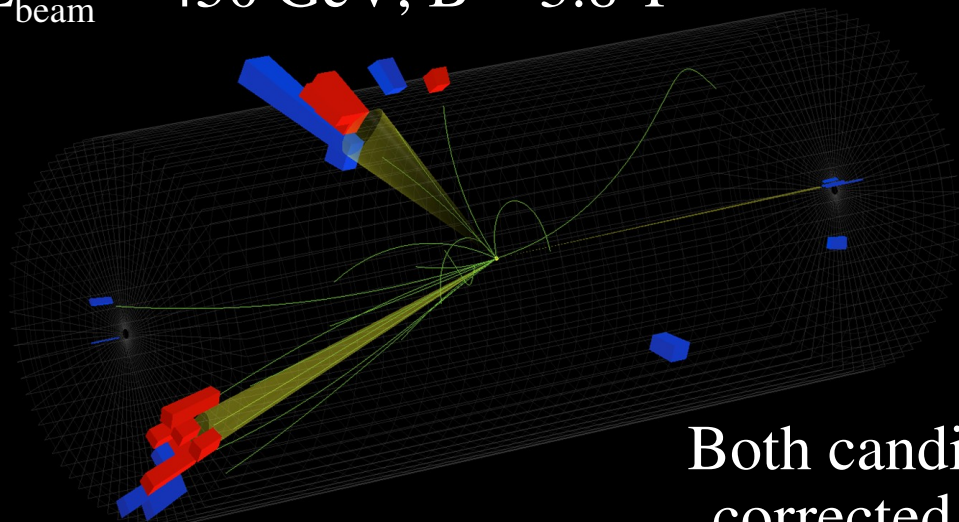
r-Z



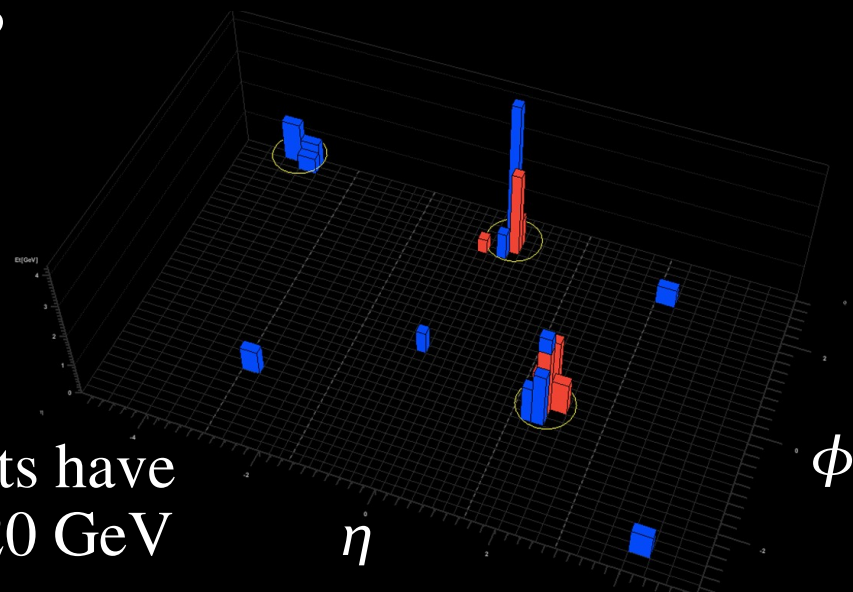
Candidate Dijet Event

Dec. 6, 2009 7:18 UTC

$E_{\text{beam}} = 450 \text{ GeV}$, $B = 3.8 \text{ T}$



η - ϕ

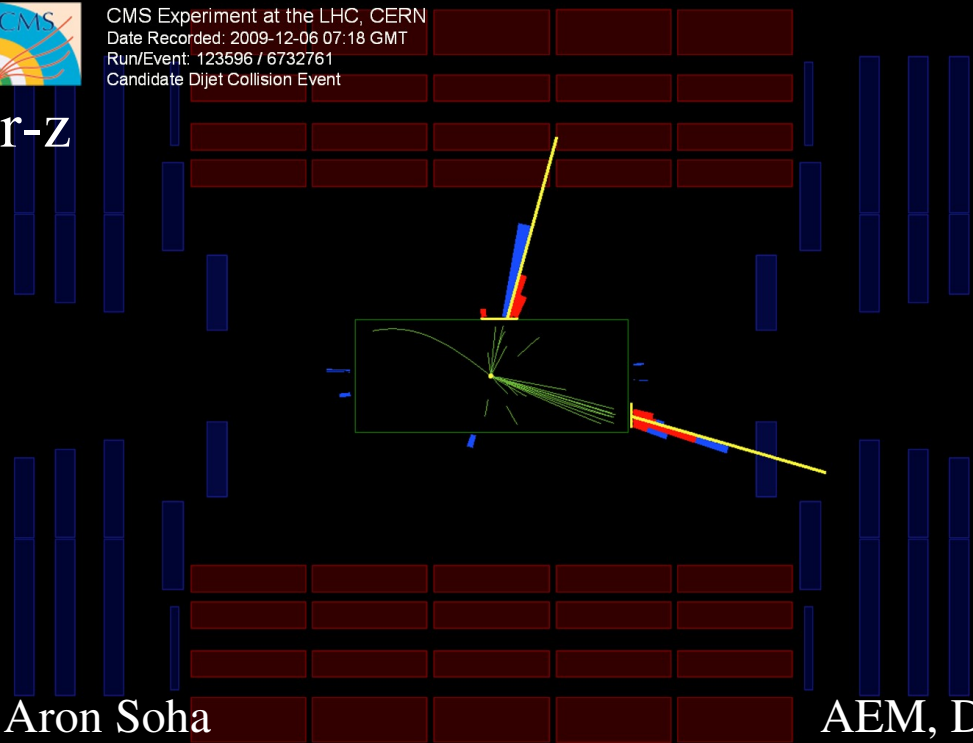


Both candidate jets have
corrected $E_T \approx 20 \text{ GeV}$



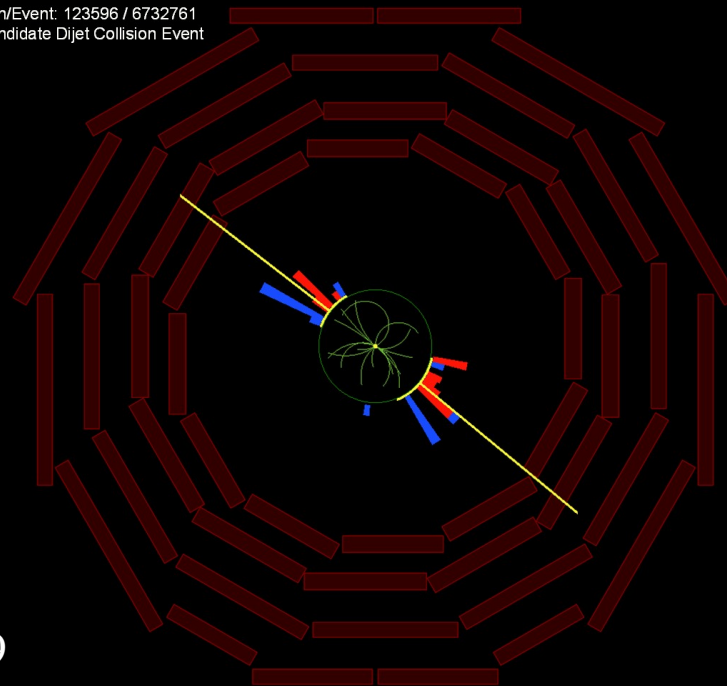
CMS Experiment at the LHC, CERN
Date Recorded: 2009-12-06 07:18 GMT
Run/Event: 123596 / 6732761
Candidate Dijet Collision Event

r - Z



CMS Experiment at the LHC, CERN
Date Recorded: 2009-12-06 07:18 GMT
Run/Event: 123596 / 6732761
Candidate Dijet Collision Event

r - ϕ

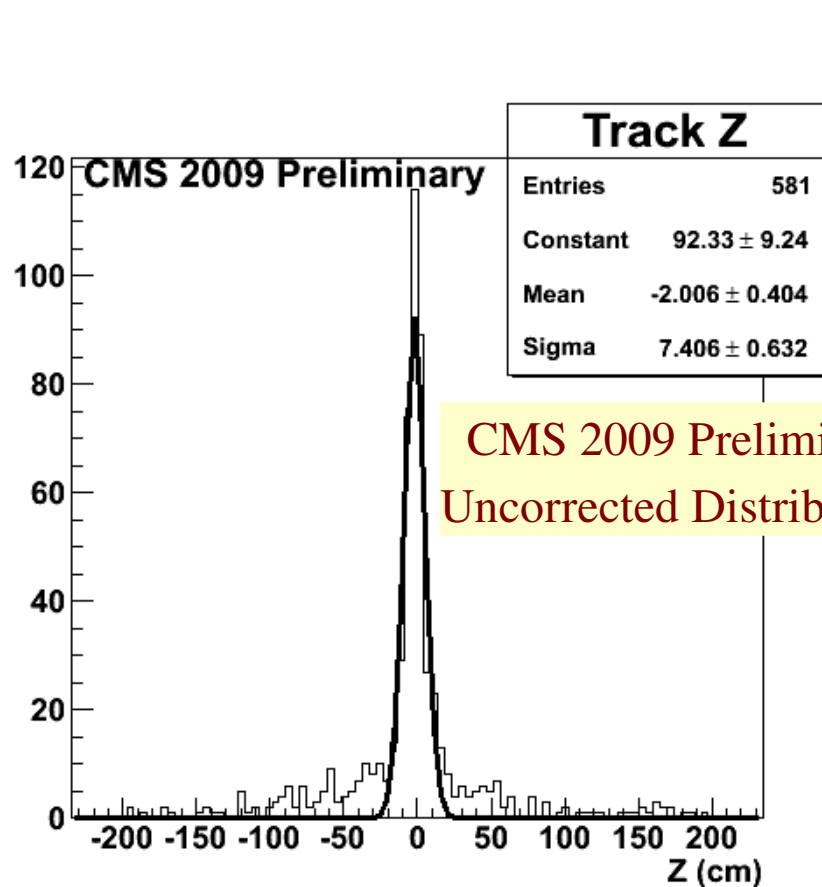




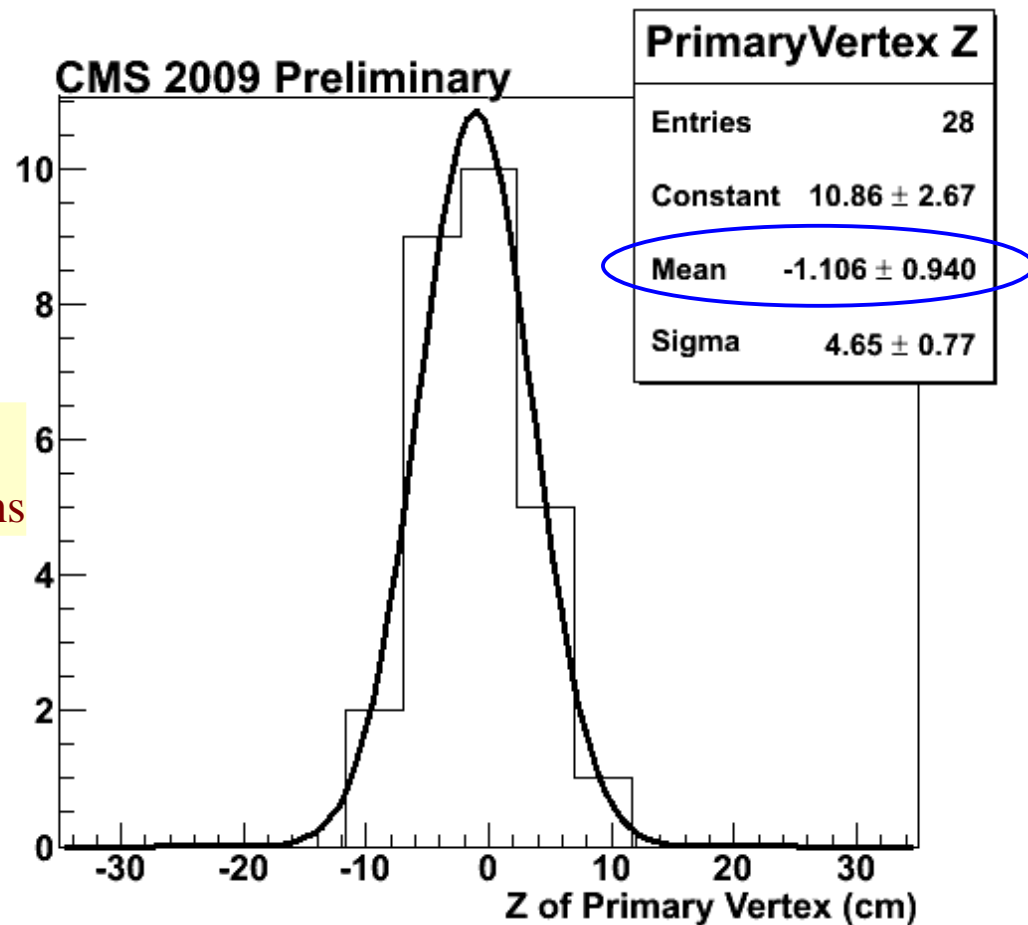
Reconstructed Vertices



- Using the Tracker Outer Barrel (4 single-sided + 2 double-sided layers)



CMS 2009 Preliminary
Uncorrected Distributions



All tracks with >6 hits and $\chi^2 < 10$

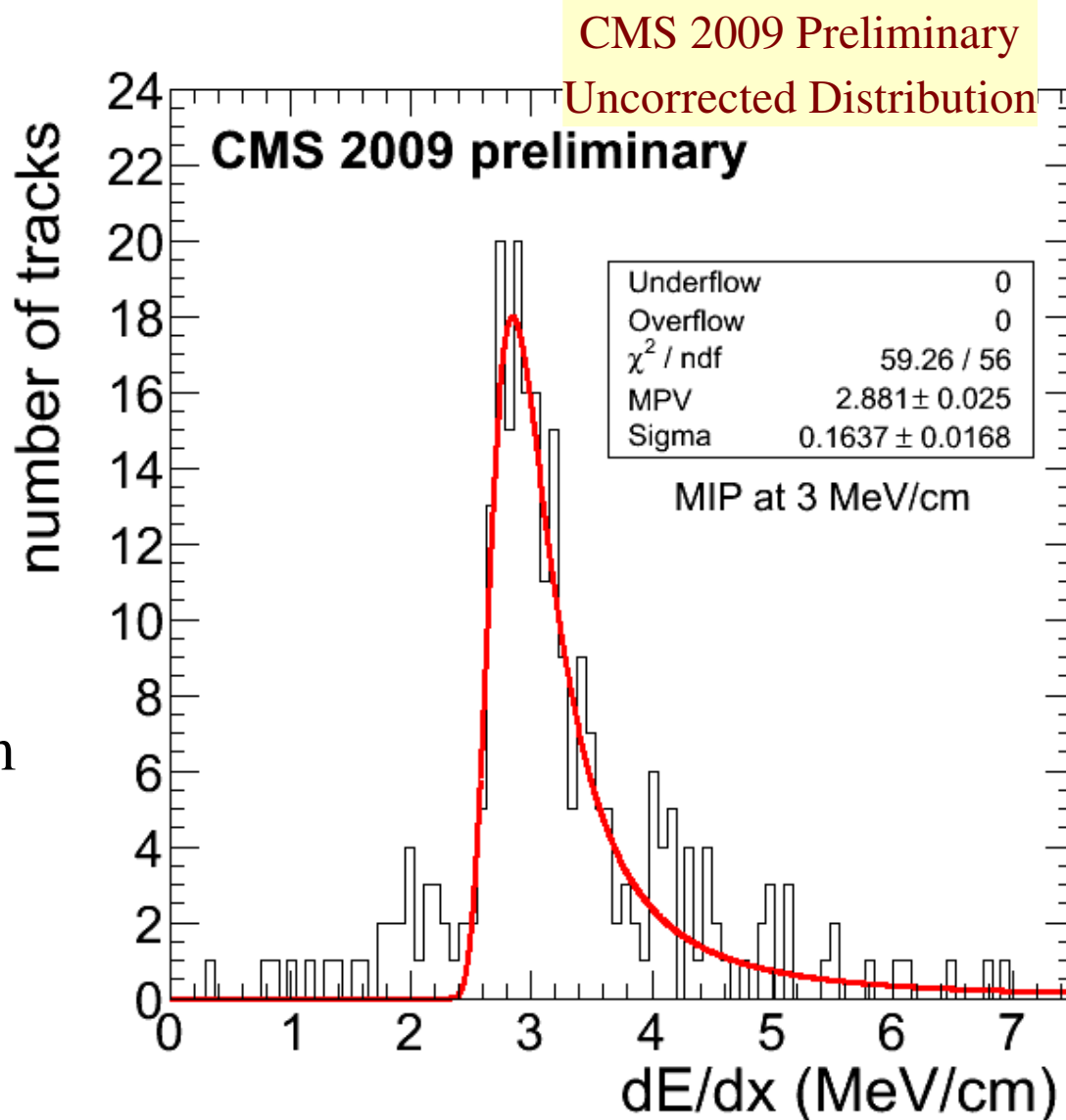
Clean vertices (≥ 3 tracks)



Track dE/dx



- Data from evening Fill of November 23
- Loose track quality selection
- 3 MeV/cm, compatible with minimum ionizing particles
- Upper tail from low momentum tracks (since no B-field for this data)

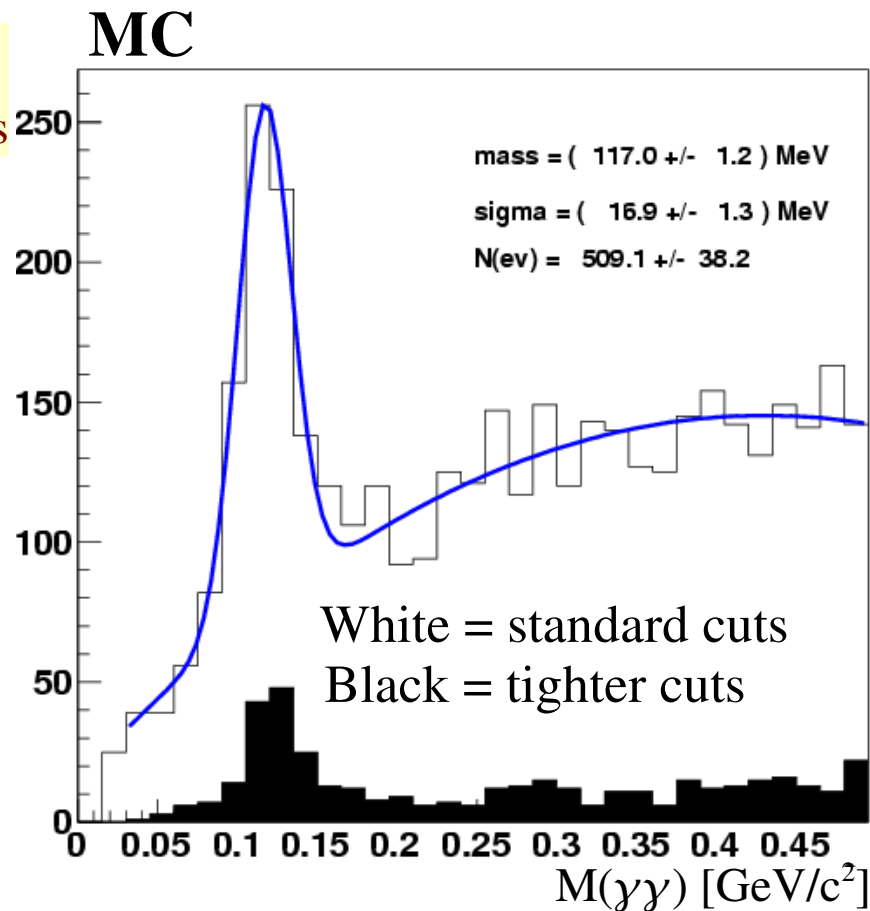
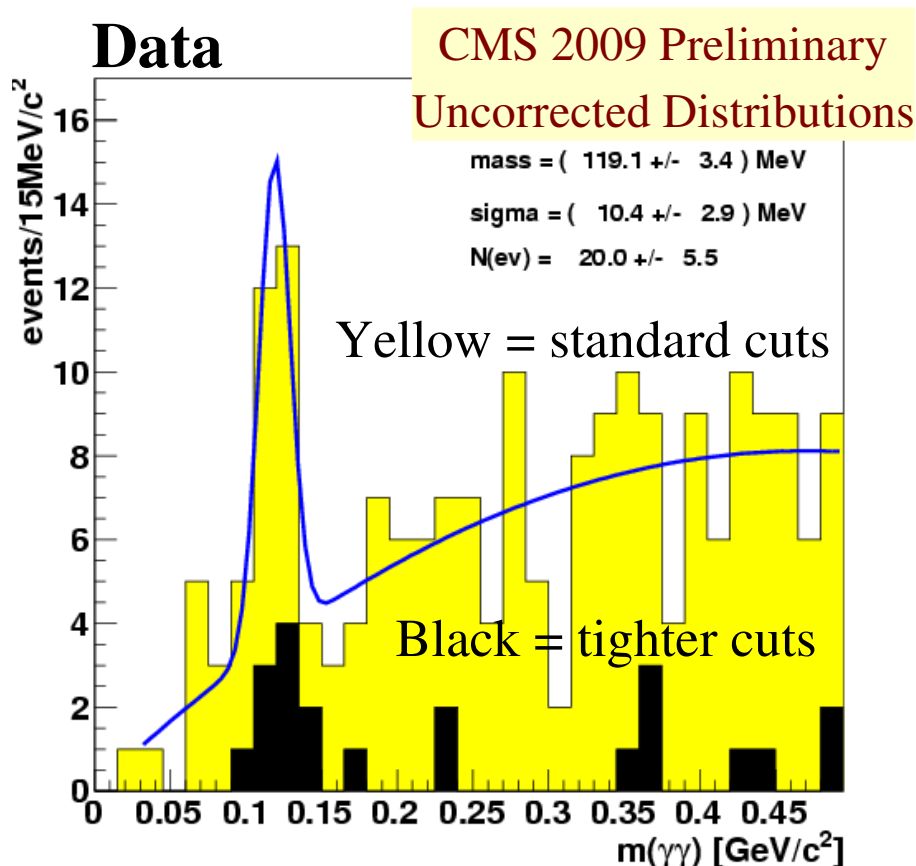




Di-photon Resonance: π^0



- Minimum bias trigger (191 events)
- Selection: 3x3 crystals; $E_T(\gamma) > 300$ MeV; $E_T(\pi^0) > 900$ MeV; shower shape



- $M(\pi^0)$ is low in both data and MC
 - Mostly due to readout threshold of 100 MeV / crystal
 - Also, part of energy is deposited upstream of ECAL due to conversions



LHC Commissioning



Interspersed with the above ...

- Rapid progress commissioning with beams at pilot bunch intensities
 - Typically $5E9$ protons / bunch
- RF capture and cogging adjustments
- Work on LHC beam dump system
- Machine protection system
- Aperture scans and collimator studies
- Kick response studies and orbit stability measurements
- Frequent “pre-cycling” of magnets to improve field reproducibility



Interruptions



- CERN power outage Tuesday night
 - Power tripped in multiple sectors, cryo did not suffer
- 3 or 4 cases in past 3 weeks when 1 (of 2) CMS solenoid magnet cryo dry compressors stopped. Field dropped from 3.8 T to 3.5 T. Restarted within 30 minutes. Cause is being investigated.
- Tracker cooling master Programmable Logic Controller (PLC) failed, causing trip of tracker cooling plant. PLC replaced on Friday.
- Friday: command sequence from CERN Central Control room to power converters of experiment magnets caused slow current dump of CMS solenoid. Went down to 2.7 T. Immediately asked to be removed from this signal path.
- Down most of today due to another power glitch



Plans



Short term ...

- Re-establish beams tonight
 - Go for stable beams with 4x4 bunches of $\sim 7E9$ protons / bunch
- Work on RF phase adjustment for collision point, beam position interlock, abort gap, injection sequence, collimation, ...
- Ramp tests tomorrow night

For the rest of 2009 ...

- Continue to increase beam intensities
- Aiming for 1.1 TeV on 1.1 TeV collisions this year
- CMS will continue to adapt to take data in all safe beam conditions
- Calibrating, aligning, and even analyzing!